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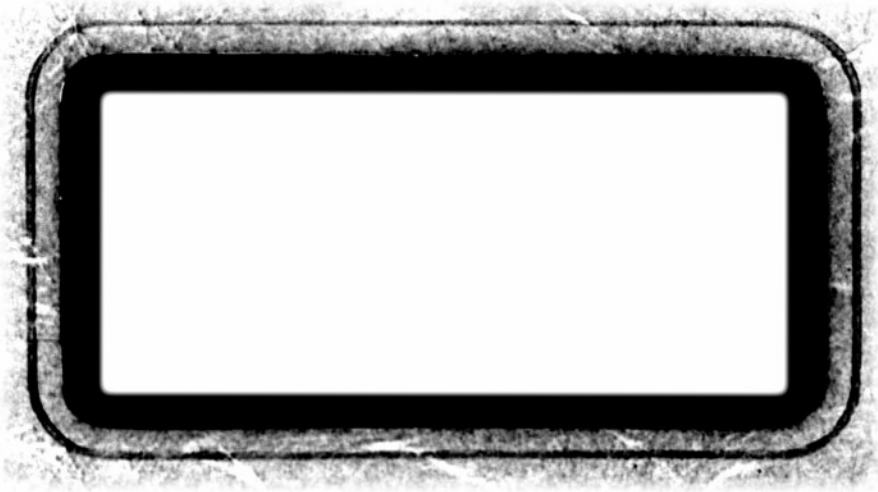

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PROGRESS REPORT NO. 35

15 SEPTEMBER 1953 to 15 DECEMBER 1953

RTV-N-12a VIKING

Engineering Report No. 6164

Cy 11

CONTRACT N6-onr-171 DETAIL SPECIFICATION

CONDUCTED BY	PREPARED BY	CHECKED WITNESSED BY	APPROVED BY
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GLM 060124

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SUMMARY

This report covers the Contractor's progress for the period 15 September through 15 December 1953 in the design, development, construction and operation of the RTV-N-12a Viking rocket for the Naval Research Laboratory under Contract N6-onr-171.

During this period an amendment to Contract N6-onr-171 was received, authorizing the repair of Viking No. 10. This is the rocket that had sustained extensive damage in its tail section as the result of a thrust cylinder explosion and fire that occurred during an attempted firing on 30 June 1953.

All items of work being accomplished under the aforementioned amendment are progressing satisfactorily and current manufacturing schedules indicate the rocket will be ready for delivery during the next report period.

On 1 November 1953 a contract was let to Reaction Motors, Inc. for the repair of the Viking 10 powerplant. A second contract covering RMI field service representation is currently being negotiated.

In addition to the effort being expended on the repair of Viking No. 10, which is the last flight article to be delivered under Navy Contract N6-onr-171, design and manufacture of four additional rockets (identified as Vikings 11-14) is currently being conducted under Navy Contract Nonr-847(00) for the Naval Research Laboratory.

I. DESIGN AND MANUFACTURE

A. DESIGN

During this report period all of the engineering changes necessary to accomplish the repair of Viking 10, which was damaged during flight operations at WSPG (GLM ER 6001), were drawn and released to the Manufacturing Division.

These changes, which are considered desirable from the standpoint of building an improved rocket, include:

1) Alcohol Tank - Install wave guide (instrumentation).

2) Lox Tank - Install permanent door in SW side where special NRL equipment was previously installed.

3) Tail Section - To be of the Viking 11 design.

4) Instrumentation - Instrumentation to be revised per NRL Instrumentation letter for the rebuilt rocket.

5) Hydraulic System - Revised to Viking 11 system.

6) Peroxide System - Revised to Viking 11 system.

7) Controls Components - Will be Viking 11 system as modified to utilize components salvaged from No. 10.

8) Electrical System - Revised to be compatible with the systems installed in the rocket. It will be essentially the No. 11 system with changes as required to use the reworked No. 10 components and as required by the NRL Instrumentation letter.

9) Fins - Revised fin blocks in the NW and SE fins in accordance with Viking 11 drawings.

10) Powerplant Installation - Revise high pressure alcohol distribution line bulkhead fittings as per Viking No. 11.

B. MANUFACTURE

Fabrication of the tail section and fins for Viking 10 was completed and final assembly of the basic rocket was accomplished without incident. System installations are now being made.

Herein is a partial list* of recovered structural and equipment components that were found to be suitable for installation in the rebuilt rocket.

1) Nose and Forward Instrument Section - Delivered to Naval Research Laboratory.

2) Propulsion System - The powerplant and all operational components have been returned to Reaction Motors, Inc. All units suitable for reclamation will be installed on the repaired powerplant.

3) Tail Section - To be replaced completely, with exception of approximately 10% of the recovered detail parts being reusable.

4) Fuel System - Except for the replacement of one diffuser line and four flexible hoses, this system will be reused in its entirety.

5) Lox System - All components forward of the welded bulkhead fitting were salvaged. Everything aft of this point, including all small tubing will be replaced.

6) Gas System - The sphere has been pressure tested and is satisfactory for reinstallation. All tubing will be replaced.

7) Peroxide System - Both tanks will be reused. See Section II for comprehensive information on micromotors.

8) Hydraulic System - Pump and reservoir are to be reused. Replacement of the accumulator and all tubing will be necessary.

9) Electrical System - Completely replaced.

10) Instrumentation - All instrumentation aft of the in-between tank section will be replaced, along with all wiring and tubing. This includes the Government furnished commutators.

* Status of additional recovered components is presented in the following sections of this report.

II. PROPULSION

A. VIKING 10 PEROXIDE MOTORS

All of the H_2O_2 motors which had been installed on Viking 10 at the time of the aborted flight firing were returned to GLM with the rocket. These were subsequently removed and subjected to a functional test. Performance of the roll system motors was acceptable; however, when the pitch/yaw units were operated, a malfunction in the form of high pressure surges was encountered. This anomaly resulted in damage of varying degrees to all four motors. In the case of motor No. 35, the head of the unit actually ruptured (Fig. 1). The pitch/yaw motors which are located in the tail section of the rocket apparently had sustained critical fire and water damage when the tail section of the rocket exploded and burned during a scheduled flight operation on 30 June 1953 (GLM ER 6001). This was evidenced by the large quantities of oxidization found on the catalyst screen ends, when the motors were later opened.

B. POWERPLANT REPAIR

RMI powerplant No. 12 has been bench checked and released for installation in Viking 10 which is currently being rebuilt. This powerplant is being used with the aforementioned rocket since its original powerplant (No. 10) cannot be repaired in sufficient time to meet present delivery schedules.

A repair contract for the damaged engine was let to Reaction Motors, Inc. on 1 November 1953. Delivery will be made in April 1954 and this powerplant will be installed in Viking No. 14 (Vikings 11 through 14 are currently being designed and manufactured under Navy Contract Nonr-847(00).

C. MAIN TANKS

The liquid oxygen and alcohol tanks for Viking No. 10 were reconditioned and pressure tested prior to their release to manufacturing for final assembly. Some difficulty was encountered during the cleansing of the alcohol tank when evidence of contamination was found in the forward end of the tank. Concentrated scrubbing with added detergent was required before the condition was rectified.

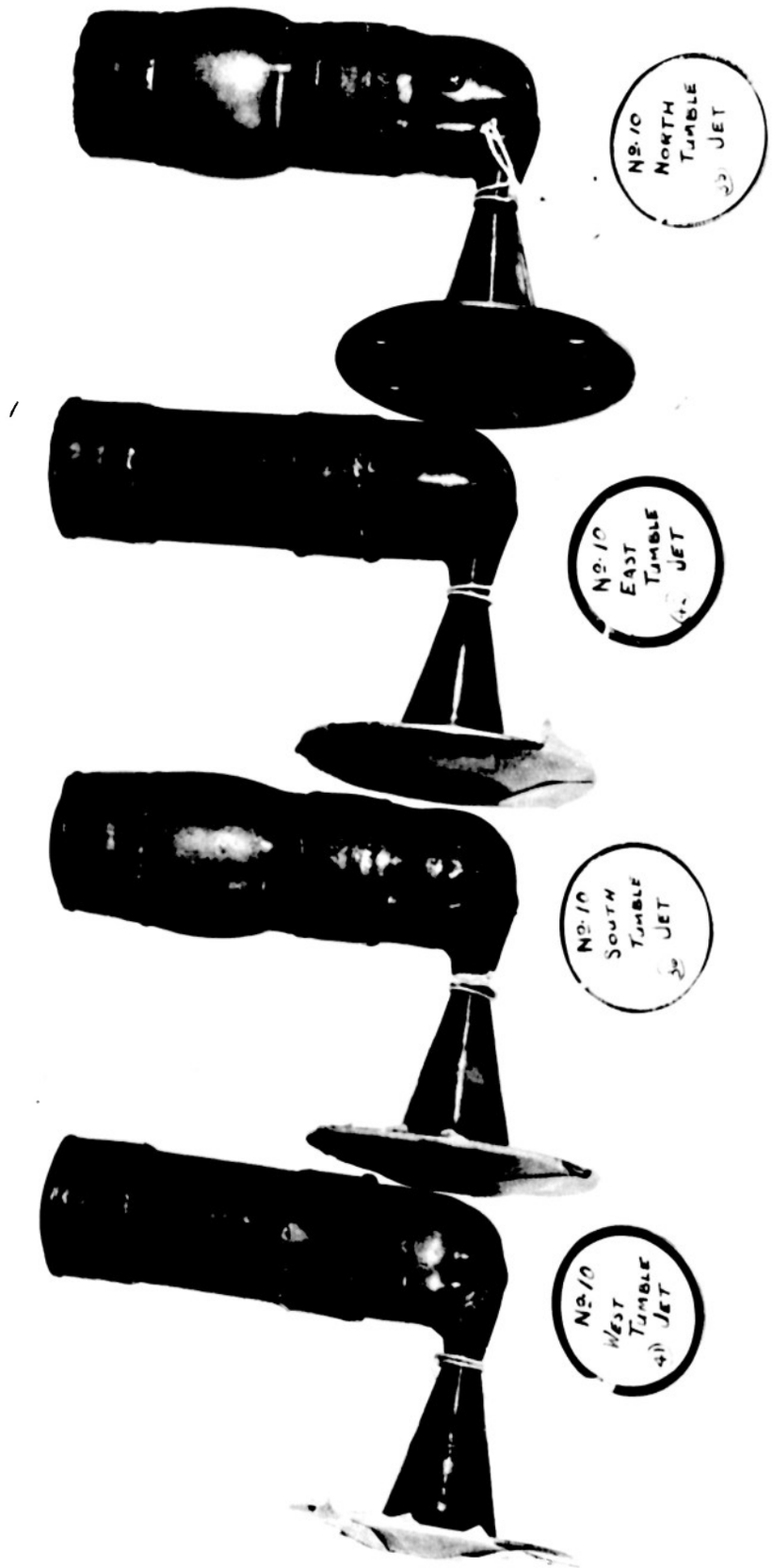

Fig. 1. Hydrogen Peroxide Motors from Viking No. 10 Damaged During Retest

III. AERODYNAMICS

Fin alignment on rebuilt Viking No. 10 was completed during this report period. Of the original fins on this rocket only two could be salvaged for reuse. The SE fin was returned to Viking 10 and the NE fin was installed on Viking 11. The latter installation was made in order to facilitate manufacturing schedules. The NW and SW fins were damaged beyond repair and were therefore rejected as unusable.

The repair of Viking No. 10 when complete will include a control system which has been designed for Viking No. 11, under Navy Contract Nonr-847(00). A theoretical analysis of this system (Section IV) shows the rocket's control and response to be better than that obtained with the system used in Viking No. 10. Provided no further changes are made in the present system, it is concluded that no alteration will be necessary to the existing Viking No. 10 ground command control charts.

IV. CONTROLS

A. VIKING NO. 10 CONTROLS COMPONENTS

Following the return of all recovered Viking No. 10 flight components, a salvage evaluation was made of each item for the purpose of determining its possible reuse. With exception of the forward controls can, gyros, and related connectors, all controls units which had been recovered from the rocket had to be written off as "not repairable". This included the spools and valve blocks which were salvaged from the servo packages for possible reclamation.

B. VIKING NO. 10 CONTROL SYSTEM

When repair of the damaged rocket was first proposed, a comparison of the Viking No. 10 control system and the improved system to be installed in Viking No. 11 was made. As a result of this study it was decided to rebuild the damaged rocket using the latter system. Reasons for this conclusion were:

1) Although flight performance of the pitch/yaw control system had been proven, considerable difficulty was always encountered in obtaining a satisfactory performance with the type transfer valve employed in the Viking No. 10 system. Use of a Type 907 Moog valve in the Viking No. 11 design is also considered to offer a definite improvement in set-up time, performance, and reliability. The operating characteristics and adjustments of related electronic components likewise represent a considerable improvement over the older design.

2) Performance of the H_2O_2 jet motor control system as well as the aerodynamic roll tab control system had been improved in the Viking 11-14 design and is better established through a series of dynamic mock-up tests. Since the older systems could not be considered as satisfactorily flight proven it was desirable that the control system of the rebuilt rocket incorporate these new features.

C. CONTROLS CAN

Following a decision to rebuild the tail section for Viking No. 10, a spare No. 10 main controls can was rewired internally to conform with the No. 11 main can circuitry. With the exception of changes required

by the addition of peroxide jet motor control slave relays and a physical separation of the two roll valves, the wiring of Viking No. 10 remained basically unchanged. At present both recovered forward controls cans and their chassis have been reconditioned and inspected. The rewired main controls can has been inspected and checked out operationally.

D. GROUND EQUIPMENT

During this period the portable terminal cart and the controls firing panel were completely rewired and in some cases the components were repackaged. This equipment has been made compatible for the factory checkout of Viking No. 10 as well as the Viking 11-14 series.

V. STRUCTURES

A. GIMBAL RING PINS

As a result of the failure of two gimbal ring pins during the attempted flight and explosion of Viking No. 10, it was considered necessary to verify the ultimate strength of these pins relative to other components in the powerplant system subjected to the explosion. To accomplish this, destruction tests were made on four pins using a test fixture. Pins, bushings, and bearings from existing stock were used in the tests. The following results were obtained:

Pin No.	Undercut Dia. (Inches)	Ult. Load Lbs./Pin	Time to Ult. Load (Secs.)
1	.6947	27,000	2.5
2	.6907	25,900	2.5
3	.6972	25,100	3.0
4	.6931	28,800	2.5

Limit Load = 12,000 lbs./pin

An effort was made to apply the load at the maximum rate in order to simulate the thrust buildup time of the rocket engine. Maximum pin overhang (bushing to bearing) of 0.7 inches was used in all cases. Failure occurred at the undercut diameter from bending and shear. The pin bent before failure to an angle of approximately 5 degrees.

The ultimate strength of the weakest pin being 13,100 pounds greater than limit load, or corresponding to a rocket thrust of 50,200 pounds, it is felt that the design of the gimbal ring pins is adequate, particularly when compared to the strength of the rocket motor.

Because the pin material (SAE 4140) is relatively insensitive to even high velocity impact loads, it is believed that the pin failure in Viking No. 10 resulted from excessive pressure within the rocket chamber.

B. VIKING NO. 10 ALCOHOL TANK

Subsequent to the customer's decision to re-fly ship number 10, a proof test of the alcohol tank was conducted. The tank was subjected to various pressures and end loads that simulate flight loads during ascent (Ref. GIM ER 5092). This test was considered necessary to verify tank

strength following a partial buckling of the shell from external pressure. This external pressure occurred when alcohol continued to drain after the tank vents were closed, following the explosion in the tail section of the rocket. The pressure was finally relieved by putting a bullet hole in the upper section of the tank by means of rifle fire. The proof test of the tank was accomplished without incident and the tank has been used in repairing Viking No. 10.

VI. INSTRUMENTATION

An advance copy of the instrumentation letter for changes to Viking No. 10 installations has been received from NRL. Changes in the microwave experiment between the main propellant tanks, involving addition of a waveguide between stations 130 and 386 and elimination of coaxial power cables, and deletion of the base pressure pickup and strain gage installation are among the major revisions.

The wiring diagram which was released is very similar to the original drawing for Viking No. 10, but the diagram was separated from the master wiring diagram and assigned a new number (260-1050001).

Two additional pressure pickups are being used on the rebuilt rocket for measurement of alcohol and oxygen pump discharge pressures.

Fin temperature measurements have been reduced to seven gages on two fins (SE and NE) as shown on GLM drawing 260-0000093. One of the original fins (SE) is to be used again; two (NW and SW) were constructed without gages before the decision to rebuild was made and the second gage installation was made in a new fin.

VII. FIELD OPERATIONS

A. FIELD CREW

With the conclusion of operations in connection with the abortive flight attempt of Viking No. 10, all contractor field personnel were returned to GLM, Baltimore. It is currently planned to support future operations with Contractor's field personnel being made available on temporary assignment as required by the rocket firing schedule.

B. WEIGHING DEVICE

The Baldwin SR-4 load cells have been removed from the launch stand weighing device and returned to the manufacturer to be reconditioned and calibrated. It is expected the units will be returned to the test site not later than 1 February 1954.